2021 Energy Efficiency Top-Down Potential Prototype Analysis

Part 2: Addendum - Pathways to Applications of Top-Down Analysis

Prepared for:

California Public Utilities Commission

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1. Executive Summary

Following the completion of Guidehouse's report on the development of a prototype Top-Down potential estimation approach, the CPUC requested that Guidehouse map out, consistent with its recommendations in that report, possible ways this approach could be carried forward in the future to assist with the bi-annual Potential and Goals-setting process.

1.1 Three Pathways

This document, Part 2 of Guidehouse's report studying the use of a top-down approach to projecting energy efficiency potential[1], lays out three pathways forward for the use of top-down techniques in supporting the CPUC's needs for the Potential and Goals (PG) study. These pathways are not mutually exclusive. In some cases elements from one path are necessary preconditions for following another.

The three pathways described in this addendum are:

1. **Context and Credibility.** This is the path of least resistance. The goal of this path is to enhance the accuracy and usefulness of the existing bottom-up approach through the application of top-down techniques. As the name suggests, the principal (though not only) activity of this path is the contextualization of bottom-up outputs through explicit comparisons to "top-line" level to the historic values produced using a top-down approach.
2. **Complete Replacement.** This path is the most disruptive of the three examined. This pathway lays out the steps required to completely replace a bottom-up modeling approach to potential estimation with a top-down analysis.
3. **Hybrid (Combine and Allocate).** This path combines elements of the other two paths and contemplates a hybrid approach. Under this approach, total segment-level potential future energy efficiency savings are estimated using a top-down analysis. These top-line values are then disaggregated to an individual measure level using an existing bottom-up model or portfolio optimization tool, subject to a variety of constraints.

The first pathway is simply an informational enhancement of the existing bottom-up approach. The second two pathways are, however, more disruptive. Given the large number of downstream processes and workflows that depend on Potential and Goals study outputs a vital component in a smooth transition from a bottom-up modeling approach to a top-down or a hybrid analysis approach would be the comprehensive, detailed, and specific documentation of downstream needs.

This should cover both assumption requirements (e.g., potential must either include the effects of codes and standards or else provide a separate strip of codes and standards impacts) as well as specific output requirements (e.g., in cases where – for example – segment definitions used in the study do not precisely match those used by core users of Potential and Goals outputs).

[1] Part 1 of the report:
Guidehouse prepared for the California Public Utilities Commission, *2021 Energy Efficiency Top-Down Potential Prototype Analysis*, January 2022
https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-efficiency/cpuc-top-down-potential-final-2022-1-18.pdf

1.2 Three Cycles

Each of the three paths described above are outlined for three “cycles”. A cycle in this case refers to a Potential and Goals study cycle of two years. Cycle numbering is relative, not absolute, and implementation of multiple paths could be staggered such that the two paths may not be on the same cycle.

For example: if a decision was made to proceed immediately with implementing the Context and Credibility pathway, “Cycle 1” for this path would refer to the 2023 PG study cycle, “Cycle 2” the 2025 PG study cycle, etc. Building on this example (i.e., proceeding immediately with Context and Credibility), if a decision was made to proceed along the Hybrid path as part of the 2025 cycle, then in that cycle the Context and Credibility pathway would be in Cycle 2, whereas the Hybrid pathway would be in Cycle 1.

1.3 Structure of the Part 2 Report

The core of this addendum are sections 2 through 4, each dedicated to one of the pathways. Within each pathway section there are two or three sub-sections that identify pathway activities by cycle. Each cycle-specific sub-section is further divided into two parts: the first identifies the potential activities of that could be undertaken in that cycle, conditional on the activities of the preceding cycle and the overall goal of the pathway, and the second part discusses the pros, cons, and the overall value of those activities.

In describing the potential activities associated with each pathway Guidehouse is not making specific recommendations, but rather identifying the most reasonable path forward, given the goal of the pathway. Pathway goals were selected to cover the spectrum of possibilities for the integration of top-down analysis into the Potential and Goals study.

Once the potential activities have been identified, *then*, Guidehouse – in identifying the pros, cons, and qualitative net benefit (i.e., value) of each set of activities – provides recommendations for consideration by the CPUC and its stakeholders.

1.4 Summary

This section summarizes the potential activities for each pathway in pursuing top-down integration (Table 1) and their pros and cons and value of each path (Table 2).

Table 1: Summary of Pathway Activities

Cycle	Context and Credibility	Complete Replacement	Hybrid
1	Use CEDARS, utility customer data, and CEC aggregate historical data to develop robust estimates, by fuel and segment of:: - LCOEs of savings achieved - Absolute savings achieved - Savings relative (as % of) consumption **Compare historical trends to projected values, identify**	**Develop**: - Commercial floorspace intensity database - Residential customer intensity database **Identify** appropriate industrial and agricultural normalizing factors to enable creation of an intensity database for these sectors.	**Commercial** - Commercial floorspace intensity database - Calibrate one bottom-up scenario to segment-level top-down estimate of commercial potential. *NB: Goals still set using bottom-up, but this step provides true side-by-side comparison*. **Residential** - Residential customer intensity database **Industrial and Agricultural** - Identify appropriate industrial and agricultural normalizing factors to enable creation of an intensity database for these sectors.
2	**Repeat Cycle 1 activities.** **Begin production of a series of segment-specific market reports** targeting industrial and agricultural segments where loads are high, but EE equipment details are unclear or highly heterogenous. **Engage segment-specific expertise**, and ensure consistency across reports – not standalone efforts, but chapters in a longer reference volume.	**Top-down analysis replaces bottom-up modeling for commercial and residential sectors.** **Develop** industrial and agricultural site intensity database.	**Commercial** - Top-down analysis defines segment-level potential in all scenarios. Bottom-up model allocates potential down to measure level. **Residential** - Calibrate one bottom-up scenario to segment-level top-down estimate of residential potential. *NB: Goals still set using bottom-up, but this step provides true side-by-side comparison*. **Industrial and Agricultural**

Cycle	Context and Credibility	Complete Replacement	Hybrid
			- Industrial and agricultural site intensity database
3	**Repeat Cycle 1 and Cycle 2 activities.**	**Top-down analysis replaces bottom-up modeling for all sectors.**	**Commercial & Residential** - Top-down analysis defines segment-level potential in all scenarios. Bottom-up model allocates potential down to measure level.. **Industrial and Agricultural** - Calibrate one bottom-up scenario to segment-level top-down estimate of industrial and agricultural potential. *NB: Goals still set using bottom-up, but this step provides true side-by-side comparison*.

Table 2: Summary of Pathway Value

Cycle	Context and Credibility	Complete Replacement	Hybrid
1	**Comparison of Projected Costs & Savings to Historical Values** **Pros:** - No incremental data collection - Additional quality assurance **Cons:** - Incremental consultant cost Very High Value: increases trust in potential projection, more effective program planning and more accurate forecasting.	**Commercial Floorspace & Residential Customer Intensity Database** **Pros:** - Required for top-down replacement - Geographic & customer specific intensities useful for program planning, forecasting, and distribution planning. **Cons:** - Incremental data cost - Incremental database assembly cost High Value: Multiple use-cases for database **Industrial and Agricultural Intensity Normalizing Factors** **Pros:** - Required for segment site intensity database, itself required for top-down replacement	**Commercial Floorspace & Residential Customer Intensity Database** **Pros:** - Required for top-down replacement - Geographic & customer specific intensities useful for program planning, forecasting, and distribution planning. **Cons:** - Incremental data cost - Incremental database assembly cost High Value: Multiple use-cases for database **Industrial and Agricultural Intensity Normalizing Factors** **Pros:** - Required for segment site intensity database, itself required for top-down replacement

Cycle	Context and Credibility	Complete Replacement	Hybrid
		- Geographic & customer specific intensities useful for program planning, forecasting, and distribution planning. **Cons:** - Incremental consultant and data costs **Moderate Value:** if plan is to proceed with industrial and agricultural site database development, value is high, otherwise value is low.	- Geographic & customer specific intensities useful for program planning, forecasting, and distribution planning. **Cons:** - Incremental consultant and data costs **Moderate Value:** if plan is to proceed with industrial and agricultural site database development, value is high, otherwise value is low. **Commercial Sector Calibrated Bottom-Up Scenarios** **Pros:** - Provides side-by-side comparison with bottom-up scenarios - Preserves output granularity of bottom-up approach **Cons:** - Incremental consultant costs - Incremental CPUC staff and stakeholder time **Moderately High:** Value is conditional on desire and commitment to migrate away from purely bottom-up approach.
2	**Comparison of Projected Costs & Savings to Historical Values** As above in Cycle 1. **Development of Series of Segment-Specific Research Reports** **Pros:** - Greater specificity in measure-level outputs in challenging segments - Provides information to identify cost-effective opportunities and programs - Better calibration of long-term segment end-use forecasting.	**Commercial & Residential Complete Replacement** **Pros:** - Top-down analysis much lower cost than bottom-up modeling. - More transparent scenario sensitivity to key analyst assumptions. **Cons:** - Loss of measure-level output detail - Disruption to down-stream workflows	**Hybrid Commercial Sector Replacement** **Pros:** - Improves top-line potential projection transparency - Preserves output (measure-level) granularity - Eliminates some bottom-up model maintenance costs (market dynamics).. **Cons:** - Incremental staff, analyst, and stakeholder time related to aligning on scenario design (made possible by greater transparency).

Cycle	Context and Credibility	Complete Replacement	Hybrid
	Cons: - Incremental consultant cost above Phase 1 **High Value:** Develops a robust bank of information about noteworthy segments, based on high energy consumption and intensity, with distinctive equipment and process needs	**Low Value:** Stakeholders have identified that measure-level detail is required. **Industrial and Agricultural Site Intensity Databases** **Pros:** - Required for segment site intensity database, itself required for top-down replacement - Geographic & customer specific intensities useful for program planning, forecasting, and distribution planning. **Cons:** - Incremental consultant and data costs **High Value:** Multiple use-cases for database .	**Moderately High:** Value is conditional on desire and commitment to migrate away from purely bottom-up approach. **Residential Sector Calibrated Bottom-Up Scenarios** **Pros:** - Provides side-by-side comparison with bottom-up scenarios - Preserves output granularity of bottom-up approach **Cons:** - Incremental consultant costs - Incremental CPUC staff and stakeholder time **Moderately High:** Value is conditional on desire and commitment to migrate away from purely bottom-up approach. **Industrial and Agricultural Site Intensity Databases** **Pros:** - Required for segment site intensity database, itself required for top-down replacement - Geographic & customer specific intensities useful for program planning, forecasting, and distribution planning. **Cons:** - Incremental consultant and data costs **High Value:** Multiple use-cases for database .
3	Cycle 3 assessment is the same as Cycle 2's	**Commercial & Residential Complete Replacement** Cycle 3 assessment is the same as Cycle 2's.	**Hybrid Commercial and Residential Sector Replacement** **Pros:**

Cycle	Context and Credibility	Complete Replacement	Hybrid
		Industrial & Agricultural Complete Replacement **Pros:** - Top-down analysis much lower cost than bottom-up modeling. - More transparent scenario sensitivity to key analyst assumptions.. **Cons:** - Loss of measure-level output detail. Unclear how significant an issue this loss of granularity given the fact most outputs for these sectors are already “custom” measures. - Disruption to down-stream workflows **Moderate (Uncertain) Value:** Stakeholders have identified that measure-level detail is required, but measure-level outputs for these sectors tend to be highly abstracted, so it is unclear how much impact a complete replacement might have on stakeholders and their downstream workflows..	- Improves top-line potential projection transparency - Preserves output (measure-level) granularity - Eliminates some bottom-up model maintenance costs (market dynamics).. **Cons:** - Incremental staff, analyst, and stakeholder time related to aligning on scenario design (made possible by greater transparency). **Moderately High:** Value is conditional on desire and commitment to migrate away from purely bottom-up approach. **Industrial & Agricultural Sector Calibrated Bottom-Up Scenarios** **Pros:** - Provides side-by-side comparison with bottom-up scenarios - Preserves output granularity of bottom-up approach **Cons:** - Incremental consultant costs - Incremental CPUC staff and stakeholder time **Moderately High:** Value is conditional on desire and commitment to migrate away from purely bottom-up approach

2. Context and Credibility

Context and Credibility is the path of least resistance. The goal of this path is to enhance the accuracy and usefulness of the existing bottom-up approach through the application of top-down techniques.

As the name suggests, a core activity on this path is the contextualization of bottom-up outputs, in this case through explicit comparisons to historic values. Comparisons of projected energy efficiency potential with historical achievement (relative to consumption, as distributed by end-use, etc.) is a corner-stone of the top-down analysis. These comparisons are essential to making the argument to reviewers and stakeholders for the reasonableness of any top-down projection of energy efficiency potential, in context of what has already been achieved.

This pathway also includes the possibility of developing segment-specific market studies designed to provide stakeholders and potential study modelers with valuable industry-specific information to better calibrate projections and design programs.

The core activity of this pathway is applying a new set of (relatively simple) analytics to existing data already collected by the CPUC and other agencies. The cost of such analytics is likely to be relatively modest. The benefits of such analytics would be to provide policymakers and utility planners with greater insight into how program offerings must evolve going forward and to act as an additional quality-control “reality check” for potential modelers. Guidehouse believes that proceeding with these activities would provide significant value.

The secondary activity of this pathway is the development of industry- (segment-) specific market studies detailing common energy efficiency opportunities, contextualized by macro data. The key differentiators between the proposed studies and historically undertaken by the CPUC and others would be staffing – Guidehouse recommends the engagement of specialized industry consultants – and structure. Guidehouse recommends the development of a formal output template for reports and consistent reporting standards such that the reports developed are not just stand-alone outputs but more like chapters in a reference manual: consistent in perspective, assumptions, and goals.

The cost of this activity would, over time, be likely to be significantly higher than the core activity, which at its core is simply the exploitation of existing collected and curated data. The higher costs of this activity would be in large part due to the incremental data-gathering activities, ongoing management (to ensure consistency) and staffing needs. The benefits would be to provide substantially improved clarity and specificity of opportunities in high-value specialized segments, an increasingly important source of savings as easier-to-characterize opportunities in more conventional segments (e.g., residential water heating, commercial lighting) are exhausted. Guidehouse believes that proceeding with these activities would provide significant value.

2.1 Cycle 1

Given the relatively light touch of the Context and Credibility pathway on core Potential and Goals study activities, Cycle 1 of this pathway could begin as soon as the forthcoming Potential and Goals study cycle (2023) without unduly jeopardizing that study’s timelines.

2.1.1 Activities

In Cycle 1 the focus of this pathway should be on developing three outputs:

- **Historical LCOEs:** The estimated levelized cost of energy (LCOE) of historical savings delivered by prior year programs, split by fuel, sector/segment, and year. These values would be drawn from the CEDARS database, cross-referencing utility account data (required for segment determination[2]).

- **Historical Absolute Savings:** A summary of historical DSM achievement by fuel, sector/segment, and year. These values would be drawn from the CEDARS database, cross-referencing utility account data (required for segment determination and comparison of savings with observed segment consumption).

- **Historical Relative Savings:** A comparison of the historical absolute savings associated with cumulative measure adoption[3] to estimated historical segment-level consumption (as tracked by the CEC and scaled based on observed customer billing data[4]). Savings as a percentage of consumption (by end-use, segment, etc.) provide a consumption (and thus growth)-normalized metric for savings making trends in energy efficiency over time clearer. Comparisons of historical to projected values of this metric assist those reviewing the Potential and Goals report understand how projected trends differ from historical, and why they do.

The core activity of the Context and Credibility pathway in Cycle 1 is the comparison of the (historical) metrics above with the equivalent projected values output by the bottom-up modeling team.

As noted above, historical LCOEs should be estimated by fuel and year. These should also be estimated separately at differing levels of cross-sectional granularity: at the segment level, at the sector level, and in aggregate. Because savings can be assigned to a specific segment only via mapping savings to sites[5] this means that segment-specific savings that can be included in the average LCOE are limited to downstream programs. Scaling up to coarser levels could enable a comparison of historical LCOEs that include the costs of acquiring savings through mid- or up-stream programs.

[2] The ability to compare LCOEs by segment as well as end-use is an important diagnostic tool as the unit cost of energy efficiency within a given end-use might vary significantly across segments due to the specific equipment used in different segments for those end-uses. For example, for gas, in the HVAC end-use, the prototype top-down analysis found that the LCOE of this end-use for Lodging was less than half what it was for either Grocery or Office segments.
[3] When comparing savings to consumption for the purposes of a “sanity check” it is most appropriate to compare the savings associated with cumulative measure adoption – i.e., the total savings delivered in each year – to consumption, rather than the savings associated with incremental measure adoption (as this understates the overall magnitude of savings achieved or projected).
[4] A certain amount of data loss is inevitable as part of any data preparation process (e.g., removal of outlier or nonsensical values, etc.). Thus, comparing the CEDARs values directly to overall aggregate consumption may understate savings as a percentage of consumption. This is why calibration to utility billing data is so important for this metric.
[5] Note that nomenclature is important here: a “site” in the CEDARs database may include multiple customer accounts.

In addition to developing the historical outputs above, the team conducting this activity should work closely with the bottom-up modeling team to develop the forward-looking equivalent outputs from the measure-level modeled values. This will ensure consistency in assumptions (i.e., an “apples-to-apples” comparison).

The bottom-up modeling and analysis teams should then compare the historical trends with the projected trends on a segment-level and aggregate basis, prioritizing the segment end-use combinations with the most material impacts on overall potential.[6] Where significant discontinuity appears in the trends (e.g., a substantial step change in LCOE from the historical to the projected period) of the most material end-uses in each segment the top-down and bottom-up teams should work together to determine the cause.

The outcome of this investigation will be to either conclude that the discontinuity reveals an issue in the bottom-up modeling requiring remediation or to identify that the discontinuity is an expected outcome of some kind of structural change. For example, if the potential projection had identified significant potential for a new low-cost HVAC measure (e.g., window film) that had previously not been considered for inclusion in programs for reasons of cost-effectiveness.

The outcome of this activity would be a higher quality output projection and the provision of additional contextual information that would assist both utilities in program planning activities and the CEC in its forecasting activities (by better understanding anticipated DSM-related structural adjustments in segment-level intensities).

2.1.2 Pros, Cons, and Value

Figure 1, below, provides a summary of the pros, cons, and value of developing historical metrics of costs and savings that may be contrasted with the projected values output as part of a bottom-up Potential and Goals study.

[6] As a practical matter, given the large number of combinations of segments and end-uses, the project team should, in collaboration with the CPUC, develop a set of thresholds for the materiality of a change. For example: where the product of the percent change in LCOE and the percent savings for the given segment exceed X, investigate, otherwise ignore.

Figure 1: Summary of Context and Credibility Cycle 1 Pros, Cons, and Value

	Comparison of Projected Costs and Savings to Historical Values
Pros	• No incremental data collection required. Leverages data already in hand with CPUC and CEC. • Provides additional quality assurance by requiring explanation of most significant disconnects between historical and projected values. • Provides utilities with additional contextual information for program planning – specifically identifying changes required. • Retains measure level outputs from bottom-up model that informs goals
Cons	Incremental consultant costs (~1 month calendar time to process data on the front end, 1-2 months calendar time to apply/interpret data)
Value	Very high. Properly planned and executed this additional analysis is likely to contribute only modestly to total study costs but will yield significant benefits in the form of a more trusted projection of potential (transparent quality assurance), more effective program planning by utilities (reducing the cost of acquiring energy efficiency), and more accurate forecasting by the CEC.

Careful, collaborative planning will be required to maximize value. The criteria for investigation of discontinuities between historical values and projected values must be precisely defined upfront to ensure alignment of expectations and to avoid detailed review of discontinuities that minimally affect the Goals or other outcomes. The format and shape of outputs should be socialized with key stakeholders (e.g., IOUs, the CEC) before work begins to ensure as much alignment as possible to these stakeholders' program planning and forecasting workflows.

2.2 Cycle 2 & Cycle 3

In Cycle 2 and Cycle 3, the core activities (defined in Cycle 1) for the Context and Credibility pathway would be repeated, evolving approaches, methods, and outputs to reflect the lessons learned in prior cycles. Starting in Cycle 2, the secondary activity, the development of segment-specific market studies could begin.

2.2.1 Activities

A key challenge of forward-looking energy efficiency potential estimation is that a material proportion of potential energy savings lies in segments where the opportunities for savings are in relatively specialized equipment and processes.

The heterogenous nature of these (primarily industrial and agricultural) industries means that there are relatively few professionals working in energy efficiency with the expertise in these areas. This can limit the precision of estimated potential in these segments and makes successful program design and accurate load forecasting for these segments more challenging.

There could be a significant benefit in undertaking additional information gathering in these segments to equip analysts and reviewers with the segment-specific context to more precisely define the potential of – and more successfully design programs for – these segments. CPUC has funded similar studies for select segments in the past including under the current PG contract, though Guidehouse's recommended approach for developing future reports includes a few crucial differentiators.

- **Segment Expertise.** *The report development team must be made up of two distinct groups: segment-specific consultants and energy efficiency experts (CPUC staff or contractors).* The segment-specific consultants should be selected from specialty consultancies serving the specific segment under review, preferably staffed with consultants drawn from the industry in question and with many years of experience. These contributors should not be expected to be experts in (or even very conversant with) the conventions of energy efficiency analysis. Their principal contribution is a deep understanding of the segment and its processes and access to decision-making individuals within those segments.

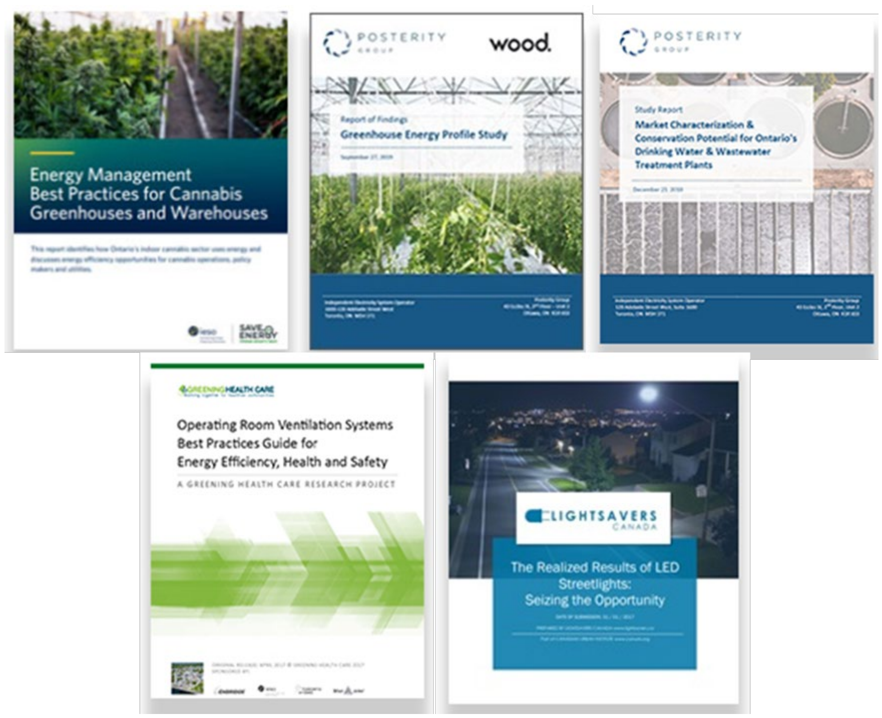
- **Consistent Output Formats.** *The recommended market reports are not intended as stand-alone reports but instead incremental chapters in a larger reference work* that can be used by the CPUC and its stakeholders for ongoing planning and forecasting activities. As such reports (and associated data output sheets) must follow a consistent output format, adopt the same reporting conventions and ensure that when situating segment-specific detail within the larger context of the sector or segment, that core assumptions match those in other reports (e.g., in terms of NAICS code mapping, etc.)

- **Continuity of Staffing.** *The energy efficiency expert team tasked with delivering the reports should remain in place across all reports.* Where transitions are required (due to natural attrition or a change of vendor) explicit transition plans must be in place. These, along with a formal data management policy are required to ensure the retention of institutional memory essential for ensuring consistency in outputs and approaches over time.

- Planning the development and implementation of such studies should follow a formal prioritization process to maximize the value these reports may deliver**.** A close review of existing segment-level and utility data can help to identify the segments where energy efficiency interventions might be most impactful (e.g., most energy-intense by customer, high aggregate consumption, etc.) and where the operational details required to more precisely project energy efficiency potential are scarce.

Other jurisdictions have undertaken similar efforts on an ad hoc basis, for example Ontario's Independent Electricity System Operator has procured a number of segment and end-use specific studies[7] to enhance understanding of the energy efficiency opportunities in these segments.

Figure 2: Example - IESO's Sector Specific Publications Series



As noted above, each report should be presented in a consistent format and identify major technology categories in use and key energy efficiency technologies. In addition to the highly industry-specific detail, however, these reports should also include summary statistics derived

[7] Independent Electricity System Operator – SaveONEnergy, *Publications*, accessed February 2022 https://saveonenergy.ca/For-Business-and-Industry/Publications

from the same sources (and in a consistent way) as those used in the Potential and Goals study, for example identifying the breakdown by end-use of energy consumption (and, for electricity, peak demand) within the segment and contrasting this with sector averages.

In addition to this new incremental activity, the activity identified in Cycle 1 (comparison of projected costs and savings to historical values) should continue

2.2.2 Pros, Cons, and Value

Figure 3 below, provides a summary of the pros, cons, and value of undertaking a series of segment-specific reports intended to support ongoing planning and forecasting activities related to energy intensive segments with highly specialized processes or needs. It also repeats the summary provided above of the pros, cons, and value of developing historical metrics of costs and savings that may be contrasted with the projected values output as part of a bottom-up Potential and Goals study.

Figure 3: Summary of Context and Credibility Cycle 2 Pros, Cons, and Value

	Comparison of Projected Costs and Savings to Historical Values	Development of a Consistent Series of Segment-Specific Research Reports
Pros	• No incremental data collection required. Leverages data already in hand with CPUC and CEC. • Provides additional quality assurance by requiring explanation of most significant disconnects between historical and projected values. • Provides utilities with additional contextual information for program planning – specifically identifying changes required. • Retains measure level outputs from bottom-up model that informs goals	• Enable greater specificity in measure-level outputs in challenging segments for bottom-up modeling. For example, identifying specific equipment or process upgrades rather than simply relying "custom" measures, or being able to identify the suite of measures or energy efficiency actions that might be included under the "custom" umbrella. • Provides utility program planners with additional information to help them identify cost-effective opportunities for savings in segments with highly specific end-uses and create more targeted quasi-prescriptive programs, potentially reducing program costs. • Provides CEC forecasters with specific intelligence and context to help assist in better calibrating long-term segment end-use forecasting.
Cons	Incremental consultant costs (~1 month calendar time to process data on the front end, 1-2 months calendar time to apply/interpret data)	Incremental (and on-going) consultant costs, (4-6 months calendar time per report, may require interviews or other forms of primary data collection to supplement secondary data), stakeholder engagement costs, and CPUC management costs.
Value	<u>Very high.</u> Properly planned and executed this additional analysis is likely to contribute only modestly to total study costs but will yield significant benefits in the form of a more trusted projection of potential (transparent quality assurance), more effective program planning by utilities (reducing the cost of acquiring energy efficiency), and more accurate forecasting by the CEC.	<u>High.</u> Building a robust, consistently structured, bank of information about high-energy-consumption/high-intensity segments with idiosyncratic equipment and process needs is, in the face of disruptive energy transformations, a very "low regrets" policy. The specialist nature of energy-using processes and equipment in many segments has likely meant historically that significant cost-effective opportunities for energy savings (or fuel substitution) may have been missed.

Complete Replacement

Complete Replacement is the most disruptive path, and the most challenging to pursue. It has a high upfront cost but has the potential for lower on-going costs in subsequent cycles. The ultimate goal of this path is to entirely replace the bottom-up modeling approach with a top-down analysis.

The scope of the activities identified in this pathway is considerably greater than those described in the Context and Credibility pathway and are, consequently, described at a much higher level. The activities described in this pathway assume – for completeness – a total transition to top-down analytics across all sectors and segments over time, though of course "mixing and matching" is possible. For example, the CPUC might elect to proceed only with transitioning some segments of the industrial or agricultural sector to a top-down approach (i.e., "complete replacement"), or indeed to proceed without migrating any sectors or segments entirely to a top-down approach.

The core benefit of a complete transition from bottom-up modeling to a top-down analysis is the abstraction away from measure-level stock-and-flow modeling, and the anchoring of projected potential in observable trends in building, site, or customer energy intensity. Such abstraction can substantially reduce running costs over time by avoiding the need for continual detailed updates to measure assumptions, and ongoing maintenance and operation of a complex bottom-up model.

Naturally there would be substantial initial fixed costs, as there are for any disruptive change in a process and workflow as involved (and as tied to so many downstream processes) as the Potential and Goals study. These costs include identifying and obtaining data critical to the analysis, cleaning and linking that data, expanding the modeling framework to address all the critical scope issues of a PG study, and socializing the revised methods and data relied upon with stakeholders and obtaining buy-in.

More significantly, however, the measure-level outputs of the bottom-up modeling have been noted by many stakeholders as being essential inputs to their workflows, either directly (for integration into forecasting or program planning models) or indirectly (to provide a quality or "gut" check of top-line results).

Based on the feedback provided by stakeholders and its own review of the pros and cons, Guidehouse believes that the value of complete replacement for the residential sector is very low and the value for the complete replacement of the commercial sector is low. This judgement is based on Guidehouse's understanding of the value to stakeholders of measure-level outputs and the accuracy and precision of the measure-level inputs that generate those outputs. The prescriptive nature of measure input assumptions is appropriate in many cases for the residential sector, where equipment usage patterns are reasonably uniform across customers.

A thorough assessment of the value of complete replacement for those sectors and segments (principally agricultural and industrial) that lack much measure-level detail in the bottom-up modeling is impossible without some additional interim work – specifically the development of segment-specific site intensity databases - as described below in Section 3.1.1.3 and 3.2.1.3. Guidehouse believes that this interim work could yield material, moderately high, value, to the CPUC and California stakeholders.

All activities in this pathway require as a prerequisite the Cycle 1 activities of the Context and Credibility pathway. These activities are implicitly assumed in the Complete Replacement pathway cycle descriptions.

2.3 Cycle 1

Complete replacement of the bottom-up modeling by a top-down analysis in a single cycle would be imprudent, and almost certainly impossible at any acceptable level of rigor. Cycle 1 of the Complete Replacement pathway is dedicated to the acquisition and synthesis of data from a variety of sources to enable Cycle 2 Complete Replacement activities.

2.3.1 Activities

The Cycle 1 activities are:

1. **Commercial Floorspace Intensity Database.** Development of a database of commercial customer energy intensity

2. **Residential Customer Intensity Database.** Development of a residential customer intensity database.

3. **Industrial and Agricultural Intensity Normalizing Factors.** Identification of normalization factors to allow for the development of an industrial and agricultural site intensity database.

The engine of the prototype top-down analysis, and therefore of any future top-down potential projection, is the database of individual site intensities. Cycle 1's focus is on the development of such site databases. For a variety of reasons (identified below) the stages of development for such site database will be different for the different sectors. The sub-sections below address the sector-specific considerations for site database development.

The Complete Replacement pathway is the most disruptive. As noted in Section 1.1, given the large number of downstream processes and workflows that depend on Potential and Goals study outputs a vital component in a smooth transition from a bottom-up modeling approach to a top-down analysis approach would be the comprehensive, detailed, and specific documentation of downstream needs. This should cover both assumption requirements as well as specific output requirements.

Cycle 1 of this pathway must therefore include targeted engagement with key stakeholders individually, and as a group, to define and document required assumptions, outputs, and output formats.

2.3.1.1 Commercial Floorspace Intensity Database

The first step in moving the commercial top-down analysis from a prototype to a production analysis is to expand the building database used to evaluate the potential improvement in energy intensity by building segment. The prototype analysis used floorspace data from the CEC Building Energy Benchmarking database.[8] These data, though publicly available, are not

[8] California Energy Commission, *Building Energy Benchmarking Program*, accessed December 18, 2020 https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program

representative of the population of commercial buildings in California, being confined predominantly to those buildings with more than 50,000 square feet of floor space.

The principal activity for the commercial sector in Cycle 1 of this pathway would be the acquisition of a representative sample of floorspace data and the synthesis of these data with utility account data and CEDARS site savings data to create a more representative version of the commercial building database developed for the prototype analysis. Key data sources for floorspace data would include the California Commercial End Use Survey (CEUS) database and commercially available databases of individual building floorspace.[9]

2.3.1.2 Residential Customer Intensity Database

For single-family residential customers and for the suite-specific potential of multi-residential customers, energy intensity is typically expressed as energy use per home, segregated by structural dwelling type.

The principal activity for the residential sector in Cycle 1 would therefore be to use utility data to develop a clean and useable site database of site intensities analogous to that developed for the commercial sector. The key unknowns for this task would be identifying an approach to segregate residential customers by structural dwelling type. This could be as coarse as simply single-family versus multi-family units, but would ideally be considerably more fine-grained. Differentiation between detached and attached single family homes and multi-residential units by building type (e.g., more than or less than five stories) and ownership type (individual-owned condominiums versus building-owned rental units) would improve the precision of estimated potential.

Likewise, some approach would need to be defined to segment and quantify the floorspace of common areas by building type for multi-residential buildings. The complexity of this second element might require its deferment until Cycle 2.

2.3.1.3 Industrial and Agricultural Intensity Normalizing Factors

The core of the top-down analysis is a comparison of energy intensities. In the commercial sector, floorspace is generally recognized (once segmentation[10] is applied) as a reasonable normalizing factor for developing intensities (e.g., kWh per square foot). In the residential sector, intensities are generally expressed on a per household basis (again, after the application of segmentation, generally by structural dwelling type).

In the industrial and agricultural sectors however, floorspace data are unlikely to be available and may not be a suitable normalizing factor. Industrial and agricultural energy intensities may perhaps be better expressed as a function of outputs (either of products or of revenues) or of inputs. Obtaining such normalizing data on an individual site basis is likely, for commercially competitive reasons, to be very challenging.

Therefore, in Cycle 1, the first step for the development of an industrial and agricultural site database (to be used to compare site intensities) would be to focus on identifying the most appropriate normalizing factor that could be made available to the CPUC. This exploratory

[9] Guidehouse understands through other engagements that the firm Dun & Bradstreet offers this service.
[10] The quality of segmentation is not binary: normalization by segment will be more accurate the more fine-grained segmentation is (e.g., large, medium, and small offices versus just "offices") and the larger the sample of buildings in each segment.

process should likely begin with a consultation of industry associations. If the Context and Credibility Cycle 2 activity (segment-specific reporting) is underway, some synergies may be achievable here.

The goal for these segments in Cycle 1 is to, for all segments that may be migrated to a top-down analysis approach, identify an appropriate normalizing factor and a source for a representative sample of such data.

2.3.2 Pros, Cons, and Value

Figure 4, below, provides a summary of the pros, cons, and value of the Complete Replacement Cycle 1 pathway elements.

Figure 4: Summary of Complete Replacement Cycle 1 Pros, Cons, and Value

	Commercial Building Floorspace Database	Residential Customer Intensity Database	Industrial and Agricultural Intensity Normalizing Factors
Pros	• Representative database of commercial building intensities is a necessary pre-condition to Complete Replacement. • Database of building intensities can reduce IOU costs of EE acquisition by allowing prioritized customer targeting. • Geographic identification of intensities can be used to enhance forecasting and distribution planning activities.	• Representative database of residential customer intensities is a necessary pre-condition to Complete Replacement. • Database of customer intensities can reduce IOU costs of EE acquisition by allowing prioritized customer targeting. • Geographic identification of intensities can be used to enhance forecasting and distribution planning activities.	• Enables subsequent pathway Cycles. • Prerequisite to development of industrial and agricultural site intensity databases.
Cons	• Incremental cost of acquiring building-specific floorspace estimates. • Incremental costs of analyst time in connecting data sources to create the database. • Incremental cost of support staff time (e.g., CEDARS database managers, etc.) required to support data acquisition.	• Incremental costs of analyst time in connecting data sources to create the database. • Incremental cost of support staff time (e.g., CEDARS database managers, etc.) required to support data acquisition.	• Incremental costs of specialist industry-specific consultants (may or may not be required) • Incremental costs of consultation with industry associations to identify appropriate normalizing factors. • Incremental cost of acquiring data to be used for intensity normalizing factor.
Value	High. On the assumption that CPUC would share the building intensity database with utilities and public agencies (subject to all appropriate privacy policies), the development of this database appears to be a very “low regrets” policy, given the many possible use-cases for such a database, in addition to enabling the Complete Replacement pathway.	High. On the assumption that CPUC would share the building intensity database with utilities and public agencies (subject to all appropriate privacy policies), the development of this database appears to be a very “low regrets” policy, given the many possible use-cases for such a database, in addition to enabling the Complete Replacement pathway.	Moderate. This pathway element is of value only if there is a commitment to proceed with the development of an industrial or agricultural (or site-specific) site intensity database.

2.4 Cycle 2

In Cycle 2 of this pathway complete replacement of the bottom-up approach by a top-down analysis may begin for the commercial and residential segments conditional on the completion of the commercial and residential sector activities identified for Cycle 1.

2.4.1 Activities

The activities in Cycle 2 follow directly from those in Cycle 1 and are presented in a similar structure.

2.4.1.1 Commercial – Complete Replacement

Conditional on completion of the prerequisite activity in Cycle 1 (creation of commercial floorspace intensity database), complete replacement of bottom-up modeling with top-down analysis and projection of energy efficiency potential can be undertaken in Cycle 2. Alternatively, should Cycle 1 activities have targeted only specific segments for the prerequisite activities, complete replacement may proceed for those segments.

2.4.1.2 Residential – Complete Replacement

Conditional on completion of the prerequisite activity in Cycle 1 (creation of the residential customer intensity database), complete replacement of bottom-up modeling with top-down analysis and projection of energy efficiency potential can be undertaken in Cycle 2.

Given the substantial differences that might be required between the modeling of single-family and multi-family (particularly multi-family with common equipment and spaces), only residential single-family complete replacement might occur in this Cycle with multi-residential complete replacement taking place in subsequent Cycles.

2.4.1.3 Industrial and Agricultural Site Intensity Databases

Conditional on the identification of appropriate normalizing factors in Cycle 1, and the acquisition of data to act as a normalizing factor (or a proxy for a normalizing factor) the core activity for these sectors (or the segments selected to proceed with) is the development of a database of site intensities. The development of a database of site intensities is a prerequisite to the complete replacement of a bottom-up modeling approach with a top-down analysis.

2.4.2 Pros, Cons, and Value

Figure 5, below, provides a summary of the pros, cons, and value of the Complete Replacement Cycle 2 pathway elements.

Figure 5: Summary of Complete Replacement Cycle 2 Pros, Cons, and Value

<table>
<tr><th></th><th>Commercial – Complete Replacement</th><th>Residential – Complete Replacement</th><th>Industrial and Agricultural Site Intensity Databases</th></tr>
<tr><td>Pros</td><td colspan="2">The below is a high-level summary of some of the benefits of top-down analysis laid out in greater detail of Table 1-1 and Section 4.1 of the Part 1 report.
• Top-down analysis is much less costly than bottom-up modeling to set up and maintain (e.g., no need to maintain up-to-date list of thousands of measure inputs).
• Shift of approach from deterministic model of market dynamics to analysis of historical and contemporary contextual data and forecasts makes effects of judgement on projection more transparent: sensitivity of outcomes to assumptions much easier for stakeholders to see and test.</td><td>• Representative database of industrial and agricultural site intensities is a necessary pre-condition to Complete Replacement.
• Database of site intensities can reduce IOU costs of EE acquisition by allowing prioritized customer targeting.
• Geographic identification of intensities can be used to enhance forecasting and distribution planning activities.</td></tr>
<tr><td>Cons</td><td colspan="2">• Loss of measure-level outputs and granularity. Stakeholder consultation has identified that this is major cost and major concern for stakeholders, more so than is perhaps identified in the final top-down report (published prior to the provision of the stakeholder feedback referenced directly above).
• Work required to ensure that top-down analysis outputs could effectively feed into existing downstream workflows, either via adjustments to the top-down approach or via post-processing changes.</td><td>• Incremental cost of acquiring data to develop normalizing (intensity) factors for industrial and agricultural sites.
• Incremental costs of analyst time in connecting data sources to create the database.
• Incremental cost of support staff time (e.g., CEDARS database managers, etc.) required to support data acquisition.</td></tr>
<tr><td>Value</td><td colspan="2">• <u>Low.</u> Stakeholders (utilities and public agencies) have clearly identified to the CPUC and to Guidehouse that measure-level outputs are crucial inputs to their workflow and quality review and are therefore an essential component of any Potential and Goals study.</td><td><u>High.</u> On the assumption that CPUC would share the site intensity database with utilities and public agencies (subject to all appropriate privacy policies), the development of this database appears to be a very “low regrets” policy, given the many possible use-cases for such a database, in addition to enabling the Complete Replacement pathway.</td></tr>
</table>

2.5 Cycle 3

In Cycle 2 of this pathway complete replacement of the bottom-up approach by a top-down analysis would proceed for those sectors or segments for which it was first applied in Cycle 2 (conditional on completion of Cycle 1 prerequisites). As per above, then, in Cycle 3, Residential and Commercial sector projected energy efficiency potential would be estimated entirely using a top-down approach.[11]

Complete replacement may begin in this segment for industrial and agricultural sectors or segments for which the development of a site intensity database had been completed in the previous Cycle.

2.5.1 Activities

Conditional on completion of the prerequisite activity in Cycle 2 (development of industrial and agricultural site intensity database), complete replacement of bottom-up modeling with top-down analysis and projection of energy efficiency potential can be undertaken in Cycle 3 for the selected industrial and agricultural segments. Top-down analysis and projection of potential energy efficiency for selected commercial and residential segments where bottom-up modeling was completely replaced in Cycle 2 may continue.

[11] As noted above, this schedule of sector replacement should not be understood to be prescriptive. Guidehouse has identified in Section 3.2.2 that the value of complete sectoral replacement of the bottom-up approach by the top-down analysis is likely of low value for the Residential and Commercial sectors, given the various pros and cons, but there may be segments or sub-segments within those sectors where complete replacement could drive value. For example, the non-suite energy uses of very large multi-unit residential buildings.

2.5.2 Pros, Cons, and Value

Figure 6, below, provides a summary of the pros, cons, and value of the Complete Replacement Cycle 3 pathway elements.

Figure 6: Summary of Complete Replacement Cycle 3 Pros, Cons, and Value

	Commercial – Complete Replacement Residential – Complete Replacement	Industrial and Agricultural - Complete Replacement
Pros	The below is a high-level summary of some of the benefits of top-down analysis laid out in greater detail of Table 1-1 and Section 4.1 of the Part 1 report. • Top-down analysis is much less costly than bottom-up modeling to set up and maintain (e.g., no need to maintain up-to-date list of thousands of measure inputs). • Shift of approach from deterministic model of market dynamics to analysis of historical and contemporary contextual data and forecasts makes effects of judgement on projection more transparent: sensitivity of outcomes to assumptions much easier for stakeholders to see and test. •	
Cons	• Loss of measure-level outputs and granularity. Stakeholder consultation has identified that this is major cost and major concern for stakeholders, more so than is perhaps identified in the final top-down report (published prior to the provision of the stakeholder feedback referenced directly above). • Work required to ensure that top-down analysis outputs could effectively feed into existing downstream workflows, either via adjustments to the top-down approach or via post-processing changes.	• Loss of measure-level outputs and granularity. **It is unclear how significant this cost to stakeholder workflows would be for the industrial and agricultural sectors.** There are typically few non-custom bottom-up measure-level outputs provided for these sectors under the existing bottom-up modeling approach for reasons alluded to in the text above. • Work required to ensure that top-down analysis outputs could effectively feed into existing downstream workflows, either via adjustments to the top-down approach or via post-processing changes.
Value	Low. Stakeholders (utilities and public agencies) have clearly identified to the CPUC and to Guidehouse that measure-level outputs are crucial inputs to their workflow and quality review and are therefore an essential component of any Potential and Goals study.	Moderate (uncertain). The value of the complete replacement of bottom-up modeling by top-down analysis for industrial and agricultural sectors is highly uncertain, given the already relatively abstracted bottom-up outputs for these sectors. Additional, targeted, consultation, with selected stakeholders is recommended to develop a more precise evaluation of the overall value of this activity in this pathway.

3. Hybrid (Combine and Allocate)

The *Hybrid* pathway represents a compromise between the lightest touch of the Context and Credibility pathway and the disruption of the Complete Replacement pathway. The goal of the Hybrid pathway is use top-down analysis for the purpose of setting top-line potential savings estimates while providing measure level detail by simultaneously leveraging a bottom-up model.

The crucial elements of this compromise are:

- **Measure-Level Outputs.** The disaggregation of top-down estimates into measure level outputs using bottom-up tools to provide the measure-level detail required by stakeholders, and to allow the costs of projected potential to be reflective of the energy efficiency measures that would deliver them.

- **Incremental Change.** A commitment to incrementalism in the transfer of approaches to minimize disruptions to existing processes and workflows and to build and maintain institutional trust in the outputs of the Potential and Goals study.

The Hybrid pathway requires all the core prerequisite activities identified for the Complete Replacement activity (i.e., development of databases). The Hybrid pathway would benefit enormously from the activities specified in the Context and Credibility pathway, but they are not required.

The value of the early-stage activities for the Hybrid pathway tends to be high, in that they offer significant direct benefits for Potential and Goals estimation but may also offer additional spillover benefits to stakeholders. The value of the incremental approach laid out below is also high, conditional on the assumption of an institutional commitment to migrating the Potential and Goals study to a Hybrid approach. Incremental changes with side-by-side comparison delivers value by limiting transition risk. All such migrations will experience “growing pains”: unanticipated complications that can only fully identified through implementation. The incremental approach means that such complications will not impact the potential outputs used to set the Goals in the first year in which a potential scenario is developed using the Hybrid approach. In that first testing phase Cycle, the bottom-up outputs remain the “canonical” outputs, such that any serious issues related to the Hybrid approach outputs can be corrected prior to complete migration in the next cycle., .

3.1 Cycle 1

The focus of Cycle 1 activities are, in priority order:

4. **Commercial Floorspace Intensity Database.** Development of a database of commercial customer energy intensity (as previously described in Section 3.1.1.1

5. **Commercial Sector Calibrated Bottom-Up Scenario.** Development of a bottom-up modeling potential scenario calibrated to commercial sector top-down potential.

6. **Residential Customer Intensity Database.** Development of a residential customer intensity database (as previously described in Section 3.1.1.2).

7. **Industrial and Agricultural Intensity Normalizing Factors.** Identification of normalization factors to allow for the development of an industrial and agricultural site intensity database (as previously described in Section 3.1.1.3).

3.1.1 Activities

It is assumed that in Cycle 1 of the Hybrid pathway that bottom-up modeling will continue to deliver the "official" projection of energy efficiency potential in all segments and sectors.

The goal is, however, that an additional scenario be included beyond the core scenarios projected by the bottom-up model. This additional scenario would be a projection of energy efficiency potential estimated by the bottom-up model but calibrated to the output of a top-line (i.e., segment-level) projection of energy efficiency potential estimated using a top-down analysis.

More specifically, the activities in Cycle 1 would begin with the development of a commercial building intensity database for some (or all) building segments. This would be used in a comparative analysis that would deliver a terminal year target of energy efficiency savings associated with cumulative measure adoption. This "target" energy efficiency achievement in the terminal year of the projection period (on a segment and fuel basis) would then be used to constrain bottom-up model outputs in a single scenario output by the bottom-up model. The outcome would be such that bottom-up model outputs at the segment level are, when aggregated from the granular measure-level values, approximately equal to the top-down target values.

Modeling staff and analysts would then review these outputs and could iteratively revisit the top-down estimates depending on the reasonableness of the measure-level results provided by the bottom-up modeling. This would allow for a true side-by-side comparison of results from the status quo bottom-up approach and the hybrid approach and provide stakeholders and analysts the opportunity to validate the appropriateness of the assumptions used and to ensure that outputs continued to flow as seamlessly as possible through existing workflows.

The essential prerequisite to the goal above is the development of the commercial building intensity database described in Section 3.1.1.1 above. Additional activities already previously described that would take place in this cycle could include:

- *Development of a residential customer intensity database*, required in order to undertake a hybrid modeling exercise in subsequent cycles, described in greater detail in Section 3.1.1.2.
- *Identification of industrial and agricultural normalization factors and data collection*, required in order to enable the creation of and industrial and/or agricultural site intensity database (which, in turn would be required to undertake a hybrid modeling exercise), described in greater detail in Section 3.2.1.3.

There are a considerable number of activities in the Hybrid pathway's Cycle 1, activities that would demand considerable resources. Should the decision be made to follow the Hybrid pathway, some form of collaborative prioritization exercise should be applied to assess the most appropriate combination of activities from across the pathways to enable the Hybrid pathway Cycle 1 activities. More specifically, the development of the commercial floorspace intensity database and the application of a comparative analysis to that database are essential inputs to the creation of a bottom-up scenario that calibrates to the top-down outputs. These activities should be prioritized, with development of the residential customer database and the research into industrial and agricultural normalization factors potentially deferred until after the publication of the complete Potential and Goals study. These second, lower priority, activities are essential to enable Cycle 2, but are not directly required for the outputs of Cycle 1, and resource scheduling should account for this.

3.1.2 Pros, Cons, and Value

Most of the activities in Cycle 1 of the Hybrid pathway are drawn from other pathways, and the value assessment provided in those pathways applies equally here. The most significant incremental activity is the application of top-down estimated potential in one sector (or set of segments from one sector) as constraints in the bottom-up model. The pros, cons, and value of this incremental activity are identified below.

Figure 7, below, provides a summary of the pros, cons, and value of the Hybrid Cycle 1 pathway elements.

Figure 7: Summary of Hybrid Cycle 1 Pros, Cons, and Value

	Commercial Building Floorspace Database	Residential Customer Intensity Database	Commercial Sector Calibrated Bottom-Up Scenario	Industrial and Agricultural Intensity Normalizing Factors
Pros	• Representative database of intensities is a necessary pre-condition to the Hybrid side-by-side testing approach. • Database of building intensities can reduce IOU costs of EE acquisition by allowing prioritized customer targeting. Geographic identification of intensities can be used to enhance forecasting and distribution planning activities.		• Provides an opportunity for side-by-side testing of the proposed hybrid approach. Allows staff, analysts, and stakeholders to assess whether constraining bottom-up modeling to the allocation of measure savings to meet the top-down estimate of potential improves on the outcomes of the purely bottom-up approach (where both top-line aggregate potential values and the distribution by measure type are generated by the bottom-up model). • Preserves the output granularity (at the measure level) of the bottom-up approach.	• Enables subsequent pathway Cycles. • Prerequisite to development of industrial and agricultural site intensity databases.

	Commercial Building Floorspace Database	Residential Customer Intensity Database	Commercial Sector Calibrated Bottom-Up Scenario	Industrial and Agricultural Intensity Normalizing Factors
Cons	• Incremental cost of acquiring building-specific floorspace estimates. • Incremental costs of analyst time in connecting data sources to create the database. • Incremental cost of support staff time (e.g., CEDARS database managers, etc.) required to support data acquisition.	• Incremental costs of analyst time in connecting data sources to create the database. • Incremental cost of support staff time (e.g., CEDARS database managers, etc.) required to support data acquisition.	• Incremental costs associated with stakeholder and staff time required for additional review of commercial Hybrid scenario results and associated planning time. • Incremental costs and calendar time associated with aligning the top down and bottom-up model for the additional commercial sector scenario	• Incremental costs of specialist industry-specific consultants (may or may not be required) • Incremental costs of consultation with industry associations to identify appropriate normalizing factors. • Incremental cost of acquiring data to be used for intensity normalizing factor.
Value	<u>High.</u> On the assumption that CPUC would share the building intensity database with utilities and public agencies (subject to all appropriate privacy policies), the development of this database appears to be a very "low regrets" policy, given the many possible use-cases for such a database, in addition to enabling the Hybrid pathway.		<u>Moderately high.</u> The value to the CPUC and its stakeholders of this activity above will depend on whether there is a commitment to migrate away from the bottom-up modeling approach.	<u>Moderate.</u> This pathway element is of value only if there is a commitment to proceed with the development of an industrial or agricultural (or site-specific) site intensity database.

The value of the component elements (e.g., the intensity database) is high, and a “low regrets” policy, but if there is little interest in moving to a true hybrid approach in the medium term the value of this testing phase is limited. Conversely, if there is considerable interest in moving toward a more transparent top-down approach for defining potential but without sacrificing the output granularity of the bottom-up approach, the value of this testing phase is likely quite high.

3.2 Cycle 2

In Cycle 2, the sector (or segments) for which the Hybrid approach has been demonstrated in Cycle 1 now migrate entirely to the Hybrid approach. Sector (or segment) site intensity databases are developed for the industrial and/or agricultural sectors based on information identified in Cycle 1.

3.2.1 Activities

Commercial Sector

In Cycle 1, the bottom-up model is used to allocate top-line potential estimates projected using a top-down analysis to the measure level for one scenario for the commercial sector (or segments within that sector).

In Cycle 2, in the commercial sector *all* scenario top-level estimates are drawn from the top-down analysis. The final Goals for this sector are set based on this top-down analysis, and measure-level outputs are provided for all scenarios by calibrating the bottom-up model to meet the constraints identified by the top-down analysis, essentially using it as a portfolio optimization tool.

Residential Sector

In Cycle 1, it is assumed that a residential customer intensity database was developed. This means that in Cycle 2, that database can be used to develop a top-down projection of residential energy efficiency potential by segment, and to calibrate the bottom-up model to the top-down potential for one (test) scenario, as was done for the commercial sector in Cycle 1.

Industrial and Agricultural Sectors

In Cycle 1, it is assumed that a set of normalizing factors (and the data necessary to estimate those factors) have been identified for the segments of the agricultural and industrial sectors. In Cycle 2, these data should be collected, and an agricultural and industrial site intensity database should be developed. The development of this database is described in greater detail in Section 3.2.1.3. The development of this database will allow the first stage of Hybrid testing to be applied to these sectors in Cycle 3.

3.2.2 Pros, Cons, and Value

The key incremental activity is the completion of the movement to a Hybrid approach for the commercial sector.

Figure 7, below, provides a summary of the pros, cons, and value of the Hybrid Cycle 2 pathway elements.

Figure 8: Summary of Hybrid Cycle 2 Pros, Cons, and Value

	Hybrid Commercial Sector Potential	Residential Sector Calibrated Bottom-Up Scenario	Industrial and Agricultural Site Intensity Database
Pros	• Delivers top-line commercial energy efficiency potential estimates that are derived using the more transparent top-down approach • Preserves the output granularity (at the measure level) of the bottom-up approach. • Eliminates costs related to development of dynamic market model inputs and QC of dynamic market model mechanics.	• Provides an opportunity for side-by-side testing of the proposed hybrid approach. Allows staff, analysts, and stakeholders to assess whether constraining bottom-up modeling to the allocation of measure savings to meet the top-down estimate of potential improves on the outcomes of the purely bottom-up approach (where both top-line aggregate potential values and the distribution by measure type are generated by the bottom-up model). • Preserves the output granularity (at the measure level) of the bottom-up approach.	• Enables subsequent pathway Cycles. • Prerequisite to development of industrial and agricultural site intensity databases.
Cons	Incremental consultant costs, and staff and stakeholder time required to provide/process feedback on scenario design (and the potential development of more scenarios than in previous cycles) to ensure consensus acceptance of Potential and Goals study outputs.	• Incremental costs associated with stakeholder and staff time required for additional review of commercial Hybrid scenario results and associated planning time. • Incremental costs and calendar time associated with aligning the top down and bottom-up model for the additional residential sector scenario	• Incremental costs of specialist industry-specific consultants (may or may not be required) • Incremental costs of consultation with industry associations to identify appropriate normalizing factors. • Incremental cost of acquiring data to be used for intensity normalizing factor.

	Hybrid Commercial Sector Potential	Residential Sector Calibrated Bottom-Up Scenario	Industrial and Agricultural Site Intensity Database
Value	Moderately high. Guidehouse believes that there is considerable value in the medium to longer-term to migrate the top-line projection of potential energy efficiency from a black-box modeling approach to an analytic approach in which analyst judgement (and its impact on results) is more transparently evident. The value of this migration is enhanced by the disaggregation which minimizes disruption to downstream workflows.	Moderately high. The value to the CPUC and its stakeholders of this activity above will depend on whether there is a commitment to migrate away from the bottom-up modeling approach.	Moderate. This pathway element is of value only if there is a commitment to proceed with the development of an industrial or agricultural (or site-specific) site intensity database.

3.3 Cycle 3

In Cycle 3, the commercial sector (or segments) for which the hybrid approach was demonstrated in Cycle 1 and migrated entirely to the hybrid approach continues as in Cycle 2. The residential sector, for which the hybrid approach was demonstrated in Cycle 2 now migrates entirely to the hybrid approach, and the hybrid approach is demonstrated for one scenario for the industrial and agricultural sectors.

3.3.1 Activities

Commercial

In Cycle 2, in the commercial sector *all* scenario top-level estimates are drawn from the top-down analysis. This continues in Cycle 3. The final Goals for this sector are set based on this top-down analysis, and measure-level outputs are provided for all scenarios by calibrating the bottom-up model to meet the constraints identified by the top-down analysis.

In Cycle 2, the bottom-up model is used to allocate top-line potential estimates projected using a top-down analysis to the measure level for one scenario for the residential sector (or segments within that sector).

Residential

In Cycle 3, in the residential sector *all* scenario top-level estimates are drawn from the top-down analysis. The final Goals for this sector are set based on this top-down analysis, and measure-level outputs are provided for all scenarios by calibrating the bottom-up model to meet the constraints identified by the top-down analysis.

Industrial and Agricultural

In Cycle 2, it is assumed that an agricultural and industrial customer intensity database was developed. This means that in Cycle 3, that database can be used to develop a top-down projection of agricultural and industrial energy efficiency potential by segment, and to calibrate the bottom-up model to the top-down potential for one (test) scenario, as was done for the commercial sector in Cycle 1, and the residential sector in Cycle 2. Assuming this test goes smoothly, a complete transition to the hybrid approach for these sectors could take place in Cycle 4 (not shown in this addendum).

3.3.2 Pros, Cons, and Value

Figure 9, below, provides a summary of the pros, cons, and value of the Hybrid Cycle 2 pathway elements.

Figure 9: Summary of Hybrid Cycle 2 Pros, Cons, and Value

<table>
<tr><th></th><th>Hybrid Commercial Sector Potential</th><th>Hybrid Residential Sector Potential</th><th>Industrial and Agricultural Sectors Calibrated Bottom-Up Scenario</th></tr>
<tr><td>Pros</td><td colspan="2">• Delivers top-line commercial energy efficiency potential estimates that are derived using the more transparent top-down approach
• Preserves the output granularity (at the measure level) of the bottom-up approach.
• Eliminates costs related to development of dynamic market model inputs and QC of dynamic market model mechanics.</td><td>• Provides an opportunity for side-by-side testing of the proposed hybrid approach. Allows staff, analysts, and stakeholders to assess whether constraining bottom-up modeling to the allocation of measure savings to meet the top-down estimate of potential improves on the outcomes of the purely bottom-up approach (where both top-line aggregate potential values and the distribution by measure type are generated by the bottom-up model).
• Preserves the output granularity (at the measure level) of the bottom-up approach.</td></tr>
<tr><td>Cons</td><td colspan="2">• Incremental consultant costs, and staff and stakeholder time required to provide/process feedback on scenario design (and the potential development of more scenarios than in previous cycles) to ensure consensus acceptance of Potential and Goals study outputs.</td><td>• Incremental costs associated with stakeholder and staff time required for additional review of commercial Hybrid scenario results and associated planning time.
• Incremental costs and calendar time associated with aligning the top down and bottom-up model for the additional commercial sector scenario</td></tr>
<tr><td>Value</td><td colspan="2"><u>Moderately high.</u> Guidehouse believes that there is considerable value in the medium to longer-term to migrate the top-line projection of potential energy efficiency from a black-box modeling approach to an analytic approach in which analyst judgement (and its impact on results) is more transparently evident. The value of this migration is enhanced by the disaggregation which minimizes disruption to downstream workflows.</td><td><u>High.</u> On the assumption that CPUC would share the site intensity database with utilities and public agencies (subject to all appropriate privacy policies), the development of this database appears to be a very “low regrets” policy, given the many possible use-cases for such a database, in addition to enabling the Complete Replacement pathway.</td></tr>
</table>